Claims

What is claimed is:

Optical Fiber Preform

1. A method of manufacturing an optical fiber preform, the method comprising the steps of:

generating heat from a combustion burner having a flame produced by igniting a substantially hydrogen-free fuel;

flowing a glass precursor into the flame to produce silica-containing soot; and

depositing the silica-containing soot onto a rotating substrate.

2. The method of claim 1 wherein the glass precursor is selected from a group consisting of a germanium-containing compound, a fluorine-containing compound, and combinations thereof.

3. The method of claim 1 wherein the glass precursor is selected from a group consisting of $SiCl_4$, $GeCl_4$, fluorohalocarbons, chlorofluorosilanes, CF_4, SiF_4, NF_3, SF_6, and combinations thereof.

4. The method of claim 1 further comprising a step of including the preform within a substantially water-free atmosphere during the step of depositing.

5. The method of claim 4 wherein the substantially water-free atmosphere is selected from a group consisting of dried air, dry nitrogen, dry oxygen, dry argon, dry helium, dry carbon dioxide, and combinations thereof.

6. The method of claim 4 wherein the substantially water-free atmosphere further comprises less than about 1% relative humidity at a temperature range between about -67°C and about 125°C.

7. The method of claim 4 wherein the substantially water-free atmosphere further comprises less than about 10 ppm water vapor.

8. The method of claim 4 wherein the substantially water-free atmosphere further comprises less than about 3 ppm water vapor.

9. The method of claim 4 wherein the substantially water-free atmosphere further comprises less than about 1 ppm water vapor.

10. The method of claim 4 further comprising the steps of:
including the substantially water-free atmosphere within a housing wherein the preform is mounted within the housing.

11. The method of claim 10 further comprising a step of mounting at least a portion of the combustion burner within the housing.

12. The method of claim 1 comprising the additional steps of:
transferring the preform to another location for further processing, and during the transfer including the preform within a substantially water-free atmosphere.

13. The method of claim 12 further comprising a step of:
inserting the preform into a carrier container including the substantially water-free environment.

14. The method of claim 13 further comprising a step of:
transferring the preform in the carrier container to another processing step.

15. The method of claim 14 further comprising a step of:
subjecting the preform to a purge of substantially dry gas during the step of transferring.

16. The method of claim 14 wherein the gas for the dry gas purge is selected from a group of dried air, dry nitrogen, dry oxygen, dry argon, dry helium, dry carbon dioxide, and combinations thereof.

17. The method of claim 1 wherein the substantially hydrogen-free fuel comprises carbon monoxide.

18. The method of claim 1 further comprising a step of flowing fluorine or a fluorine-containing compound into the flame to produce a fluorine-doped, silica-containing soot.

19. The method of claim 18 wherein the fluorine-containing compound is selected from a group of F, F_2, CF_4, C_2F_6, SF_6, NF_3, SiF_4, chlorofluorosilanes, and combinations thereof.

20. The method of claim 18 further comprising a step of flowing the fluorine-containing compound into the flame from an expelling element at least partly surrounding the flame.

21. The method of claim 20 further comprising a step of expelling the fluorine containing-compound from a plurality of radially directed ports formed in a ring.

22. The method of claim 21 further comprising a step of flowing the fluorine containing-compound from a shield included within the combustion burner.

23. The method of claim 1 further comprising a step of heating at least one end of the preform with at least one end burner, the at least one end burner combusting a substantially hydrogen-free fuel.

24. The method of claim 1 further comprising a step of laying down a first segment including the silica-containing soot onto the rotating substrate.

25. The method of claim 24 further comprising a step of doping the silica-containing soot to include a dopant in the first segment.

26. The method of claim 25 wherein the first segment includes a germania dopant.

27. The method of claim 24 further comprising a step of laying down a second segment of silica-containing soot adjacent to the first segment.

28. The method of claim 27 wherein the second segment includes a fluorine dopant.

29. The method of claim 28 further comprising a step of laying down a third segment of silica-containing soot adjacent to the second segment.

30. The method of claim 29 further comprising a step of laying down a fourth segment of silica-containing soot including adjacent to the third segment.

31. The method of claim 30 wherein the fourth segment includes a fluorine dopant.

32. The method of claim 1 further comprising an additional step of laying down an additional silica-containing soot segment within the soot preform by introducing a silica-containing precursor into a flame produced by igniting a hydrogen-containing fuel thereby forming two silica-containing soot segments, a first one formed by igniting a substantially hydrogen-free fuel, and the additional one by igniting a hydrogen containing fuel.

33. The method of claim 1 further wherein the glass precursor comprises $SiCl_4$.

34. The method of claim 1 further comprising a step of forming during deposition, by vitrifying the soot, at least one glassy barrier layer within the soot preform.

35. The method of claim 34 wherein the glassy barrier layer further comprises a thickness of less than 200 μm.

36. The method of claim 34 wherein the glassy barrier layer is formed within the soot preform and includes soot on inner and outer radial sides thereof.

37. The method of claim 34 wherein a thickness of the glassy barrier layer is less than about 100 μm.

38. The method of claim 34 wherein a thickness of the glassy barrier layer is less than about 30 μm.

39. The method of claim 34 further comprising a step of forming a first and second soot segment within the soot preform, wherein at least one soot segment includes a dopant, and the glassy barrier layer minimizes migration of the dopant between the segments.

40. The method of claim 39 wherein the dopant comprises fluorine.

41. The method of claim 34 wherein a thickness of the glassy barrier layer is between about 10 μm and 200 μm.

42. The method of claim 1 further comprising a step of supplying a substantially dry environment to the preform by passing supply gas through a chiller to chill the air to a temperature below about -40 °C.

43. The method of claim 1 further comprising a step of supplying a substantially dry environment to the preform by passing supply gas through a molecular sieve.

44. The method of claim 1 further comprising a step of supplying a substantially dry environment to the preform by:

first passing supply gas through a chiller to produce chilled supply gas with a first level of humidity,

then passing the chilled supply gas with a first level of humidity through a molecular sieve to generate a chilled and sieved gas with a second level of humidity, and

supplying a chilled and sieved gas with a second level of humidity to the preform to supply the substantially dry environment.

45. The method of claim 1 further comprising a steps of:

flowing from a supply system a substantially dry environment to a housing containing the soot preform, and

recycling an exhaust from the housing back to the supply system.

46. The method of claim 1 further comprising a step of transferring the soot preform to a consolidation furnace while subjecting the preform to a substantially dry environment during the step of transferring.

47. The method of claim 1 further comprising a steps:

transferring the soot preform from the step of depositing to a consolidation furnace within a carrier container, and

inserting the carrier container and soot preform into the consolidation furnace.

48. The method of claim 1 further comprising a steps of:

forming a muffle tube of a consolidation furnace from a wall of a carrier container used to transport the soot preform from the step of deposition, and

including the soot preform within the carrier container.

49. The method of claim 1 further comprising the step of supplying the substantially hydrogen-free fuel and glass precursor in a flow ratio of flow of fuel to flow of precursor that is greater than 20:1.

50. The method of claim 1 further comprising the steps of:

supplying at a first flow rate, the glass precursor to a center fume passage of the combustion burner; and

supplying the substantially hydrogen-free fuel to a fuel passage surrounding the center fume passage at a flow rate at least 20 times the first flow rate.

51. The method of claim 50 further comprising flowing into the flame a fluorine-containing compound thereby forming during the step of depositing, a silica-containing, fluorine-doped soot.

52. The method of claim 50 further comprising a step of supplying oxygen to an inner shield passage between the fuel and the center fume passage.

53. The method of claim 1 further comprising the step of achieving fluorine doping within a segment of the silica-containing soot of greater than 1% by weight of fluorine by supplying one selected from a group of:

(a) fluorine, and

(b) a fluorine-containing compound,

in an amount less than 0.5 l/m.

Substantially Dry End Burner

54. A method of manufacturing a silica soot preform comprising a step of heating at least one end of the preform with at least one end burner, the at least one end burner combusting a substantially hydrogen-free fuel.

55. A method of manufacturing a silica soot preform comprising a step of heating both ends of the preform with end burners both of which combust a substantially hydrogen-free fuel.

56. The method of claim 54 wherein the substantially hydrogen-free fuel is carbon monoxide.

57. The method of claim 54 wherein an end burner is positioned at each unusable end of the preform.

58. The method of claim 57 wherein the end burners are positioned stationary relative to the useable ends of the preform along a longitudinal axis of the preform.

Combination CO and Conventional Deposition

59. A method of manufacturing an optical fiber preform, comprising the steps of:

generating heat from a first combustion burner having a first flame produced by igniting a one of

a hydrogen-containing fuel, and

a substantially hydrogen-free fuel;

flowing a first glass precursor into the first flame to lay down a first segment of silica-containing soot within the preform;

generating heat from a second combustion burner having a second flame produced by igniting the other one of

the hydrogen-containing fuel, and

the substantially hydrogen-free fuel; and

flowing a second glass precursor into the second flame to lay down a second segment of silica-containing soot.

60. The method of claim 59 further comprising a step of forming during deposition a first glassy barrier layer within the soot preform located at an interface between the first and second segments.

61. The method of claim 60 wherein the first glassy barrier layer has a thickness of less than 200 μm.

62. The method of claim 60 wherein the first glassy barrier layer has a thickness of less than 100 μm.

63. The method of claim 60 wherein the first glassy barrier layer has a thickness of less than 30 μm.

64. The method of claim 60 wherein the first glassy barrier layer is formed in a portion of a first or second soot segment.

65. The method of claim 64 wherein the first glassy barrier layer formed utilizing the substantially-hydrogen free fuel.

66. The method of claim 60 further comprising a second glassy barrier layer formed at an interface of the second segment and a third segment.

Glassy Barrier Layer

67. A method of manufacturing an optical fiber preform, comprising the steps of:

forming a first soot segment,

vitrifying a first portion of the first soot segment to form at least one glassy barrier layer, and

prior to consolidation of a remaining portion of the first soot segment, depositing a second soot segment on the at least one glassy barrier layer.

68. The method of claim 67 wherein at least one of the first and second soot segments includes a refractive index altering dopant.

69. The method of claim 67 wherein the first glassy barrier layer has a thickness of less than about 200 μm.

70. The method of claim 67 wherein the first glassy barrier layer has a thickness of less than about 100 μm.

71. The method of claim 67 wherein the first glassy barrier layer has a thickness of less than about 30 μm.

72. The method of claim 67 wherein the first glassy barrier layer has a thickness between about 200 μm and about 10 μm.

73. The method of claim 67 further comprising a step of adding a fluorine dopant in the second segment.

74. The method of claim 67 wherein the fluorine is present in an amount greater than 1.0% by weight for at least a portion of the second segment.

75. The method of claim 67 wherein the first and second soot segments include a core portion.

76. The method of claim 67 further comprising a step of adding a germania dopant in the first segment during deposition.

77. The method of claim 67 further comprising an additional step of adding a refractive index altering dopant to both the first and second soot segments within the preform.

78. The method of claim 67 further comprising the steps of:
doping the first soot segment with germania, and
doping the second segment with fluorine.

79. The method of claim 67 further comprising the steps of:
leaving the first soot segment undoped, and
doping the second segment with fluorine.

80. The method of claim 67 further comprising an additional step of forming a second glassy barrier layer within the preform.

81. The method of claim 80 wherein the second soot segment is positioned between the first and second glassy barrier layers.

82. The method of claim 67 further comprising a step of adding fluorine to the second soot segment.

83. The method of claim 67 wherein the glassy barrier layer is formed on a outer radial periphery of the first soot segment or an inner radial periphery of the second soot segment.

84. The method of claim 67 wherein the glassy barrier layer has a tubular shape.

85. The method of claim 67 wherein the step of vitrifying comprises firepolishing with a flame.

86. The method of claim 85 wherein the flame is produced by igniting a substantially hydrogen-free fuel.

87. The method of claim 67 wherein the step of vitrifying comprises exposing the portion to a laser beam emanating from a laser device.

88. The method of claim 87 wherein the laser device comprises a CO_2 laser.

89. The method of claim 87 wherein the laser device exhibits a spot size of between about 2.0 mm and 4.0 mm.

90. The method of claim 87 wherein the laser beam is focused through a lens and onto the portion thereby producing an exposure point.

91. The method of claim 90 wherein the exposure point includes a focused dimension between about 0.5 mm and 2.5 mm.

92. The method of claim 87 wherein the laser beam is traversed along an axial length of the preform as the preform rotates.

93. The method of claim 87 wherein an exposure point of the laser beam along an axial length of the preform during a first preform revolution overlaps an corresponding exposure point during a next preform revolution.

94. The method of claim 67 further comprising the steps of:
igniting a substantially hydrogen-free fuel to form a flame, and
flowing a precursor into a flame to form the first portion, second portion or both.

95. The method of claim 94 wherein the substantially hydrogen-free fuel comprises carbon monoxide.

96. The method of claim 94 wherein the first and second segments are deposited by a flame hydrolysis process.

97. A method of manufacturing an optical fiber preform, the method comprising the steps of:

depositing a first soot segment of silica-containing soot;

vitrifying a soot surface layer of the first soot segment to form a glassy barrier layer; and

prior to consolidation of a remaining unvitrified portion of the first soot segment, depositing a second soot segment of silica-containing soot including fluorine onto the glassy barrier layer.

98. A method of manufacturing an optical fiber preform, comprising the steps of:

depositing a first silica-containing soot region on an outside surface of a rotating substrate to a first predefined diameter;

forming a glassy barrier layer adjacent to an outermost radial extent of the first soot portion by vitrifying a surface layer of the first silica-containing soot portion; and

depositing a second silica-containing soot region including a fluorine dopant on an outside radial surface of the glassy barrier layer to a second predefined diameter.

99. An optical fiber preform, comprising:

a first soot segment;

a second soot segment; and

a vitrified barrier layer therebetween.

100. An optical fiber preform of claim 99 wherein the barrier layer has a thickness of less than about 200 μm.

101. An optical fiber preform of claim 99 wherein the barrier layer has a thickness of less than about 100 μm.

102. An optical fiber preform of claim 99 wherein the barrier layer has a thickness of less than about 30 μm.

103. An optical fiber preform of claim 99 wherein the barrier layer has a thickness of between 10 μm and about 200 μm.

104. An optical fiber preform of claim 99 wherein the first soot segment comprises a germania-doped, silica-containing soot layer.

105. An optical fiber preform of claim 99 wherein the second soot segment comprises a fluorine-doped, silica-containing soot layer.

106. An optical fiber preform of claim 99 wherein the first and second soot segments comprise a generally annular shape.

107. An optical fiber preform of claim 99 further comprising a second vitrified barrier layer located at an outer radial extent the second soot segment.

108. An optical fiber preform of claim 107 further comprising a third soot segment and a third vitrified barrier layer located at an outer radial extent of a third soot segment.

Fluorine Doped Preform Manufactured Utilizing Substantially-Water Free Fuel

109. A method for producing an optical fiber preform, comprising the steps of:

generating a flame from a combustion burner by igniting a substantially hydrogen-free fuel;

flowing into the flame, one selected from a group consisting of

a silicon-and-fluorine containing precursor, and

a silicon precursor and a separate fluorine or fluorine-containing compound,

producing fluorine-doped, silica-containing soot; and

depositing the soot onto a substrate to form an optical fiber preform.

110. The method of claim 109 wherein the silicon-and-fluorine containing precursor further comprises chlorine.

111. The method of claim 109 wherein the substantially hydrogen-free fuel comprises carbon monoxide.

112. The method of claim 109 wherein the separate fluorine or fluorine-containing compound is selected from a group consisting of F, F_2, CF_4, C_2F_6, SF_6, NF_3, and combinations thereof.

113. The method of claim 109 wherein the silicon-and-fluorine containing precursor is selected from a group consisting of SiF_4 and chlorofluorosilanes.

Chlorofluorosilane Precursor

114. A method for producing silica-containing soot, comprising a step of: reacting a chlorine, fluorine, and silica containing compound during deposition; the reaction resulting in generation of a fluorinated silica-containing soot.

115. The method of claim 114 further comprising a step of introducing the chlorine, fluorine, and silica containing compound into a flame.

116. The method of claim 115 further comprising a step of forming the flame by igniting a substantially hydrogen-free fuel.

117. The method of claim 116 wherein the substantially hydrogen free fuel comprises carbon monoxide.

118. The method of claim 114 further comprising forming the fluorinated silica-containing soot within a substantially water-free atmosphere.

119. The method of claim 114 further comprising a step of depositing the fluorinated silica-containing soot onto a substrate.

120. The method of claim 119 further comprising a step rotating the substrate.

121. The method of claim 114 further comprising a step of sintering the fluorinated silica-containing soot.

122. The method of claim 114 further comprising a step of mixing the chlorine, fluorine, and silica containing compound in gaseous form with a dilutent gas prior to the step of reacting.

123. The method of claim 114 wherein the chlorine, fluorine, and silica containing compound comprises a chlorofluorosilane.

124. The method of claim 123 wherein the chlorofluorosilane is selected from a group of $SiCl_3F$, $SiCl_2F_2$, and $SiClF_3$.

125. The method of claim 114 wherein the fluorinated silica-containing soot contains greater than about 0.5 % by weight of fluorine.

126. The method of claim 114 further comprising a step of mixing the chlorine, fluorine, and silica containing compound with a silica and chlorine containing compound to achieve a desired level of fluorine in the soot.

127. A method for producing silica-containing article, comprising the steps of:
introducing a chlorine, fluorine, and silica containing compound into a flame and generating a fluorinated silica-containing soot; and
depositing the fluorinated silica-containing soot onto a substrate.

128. A method for producing an optical fiber soot preform, comprising the steps of:
introducing a chlorofluorosilane precursor into a flame and generating a fluorinated silica-containing soot; and
depositing the fluorinated silica-containing soot onto a rotating substrate.

129. A method for producing an optical fiber soot preform, comprising the steps of:

introducing a chlorofluorosilane precursor into a flame and generating a fluorinated silica-containing soot;

depositing the fluorinated silica-containing soot onto a rotating substrate to form an optical fiber soot preform;

sintering the optical fiber soot preform to form a consolidated preform; and

drawing an optical fiber from the preform.

Photomask

130. A method for producing a vitrified glass article, the method comprising the steps:

generating heat from a combustion burner having a flame produced by igniting a substantially hydrogen-free fuel, the flame being the only source of heat;

flowing a glass precursor into the flame to produce silica containing soot; and

depositing the containing soot onto a substrate and substantially simultaneously converting the soot to form the vitrified glass article.

131. A method of claim 130 comprising an additional step of depositing the soot onto a silica-containing glass member.

132. A method of claim 131 comprising an additional step of mounting the silica-containing glass member on a bed of sand.

133. A method of claim 131 wherein the silica-containing glass member further comprises high purity fused silica glass.

134. A method of claim 130 wherein the vitrified glass article contains water in amount less than about 10 ppm.

135. A method of claim 130 wherein the step of depositing takes place within a chamber.

136. A method of claim 135 comprising an additional step of providing a purge gas into the chamber.

137. A method of claim 136 wherein the purge gas comprises nitrogen.

138. A method of claim 135 comprising an additional step of providing a pressurized atmosphere in the chamber greater than an atmospheric pressure outside of the chamber.

Burner Claims

139. A combustion burner, comprising:

a fume passage adapted to supply, at a first flow rate, a glass precursor, and

a fuel passage surrounding the center fume passage, the fuel passage adapted to supply a substantially hydrogen-free fuel at a flow rate at least 20 times the first flow rate.

140. The burner of claim 139 further comprising an inner shield passage between the fuel passage and the fume passage adapted to supply oxygen.

141. The burner of claim 139 further comprising a water cooling jacket surrounding the fuel passage.

142. The burner of claim 139 further comprising an outer shield passage surrounding the fuel passage.

143. The burner of claim 139 wherein the fuel passage tapers inwardly near its terminal end.

144. A combustion burner, comprising:

a center tube adapted to provide a hydrogen-free glass precursor into a flame region, the center tube located along a central axis of the burner;

an inner shield unit adapted to provide at least oxygen into the flame region, the inner shield unit radially displaced from the central axis of the burner;

a fuel passage adapted to supply substantially hydrogen free fuel to the flame region; and

an outer shield unit adapted to provide a fluorine containing gas enshrouding the flame region, the outer shield region radially displaced from the central axis of the burner and positioned outside the inner shield unit and the fuel passage, the burner being adapted for producing substantially water-free, fluorine doped silica.

145. A combustion burner, comprising:

a fume passage adapted to provide a glass precursor;

an inner shield passage radially positioned outside the fume passage;

a fuel passage adjacent to the inner shield adapted to provide substantially hydrogen free fuel; and

an outer shield region radially positioned outside the fuel passage.

Efficient Fluorine Doping

146. A method of producing a fluorine doped article, comprising the step of: depositing fluorinated silica-containing soot containing greater than 0.5% by weight of fluorine by supplying into a flame, in an amount less than 0.5 liters/minute, fluorine or a fluorine-containing compound.

147. A method of claim 146 further comprising the step of: depositing silica-containing soot of greater than 1% by weight.

148. A method of claim 146 further comprising the step of: supplying fluorine from an expelling element into the flame.

149. A method of claim 148 wherein the expelling element further comprises a plurality of ports radially spaced around and directed towards the flame.

150. The method of claim 146 further comprising a step of supplying the flame with a substantially hydrogen free fuel.

151. The method of claim 150 wherein the substantially hydrogen free fuel comprises carbon monoxide.

152. The method of claim 146 further comprising a step of forming the fluorinated silica-containing soot within a substantially water-free atmosphere.

153. The method of claim 146 further comprising a step of depositing the fluorinated silica-containing soot onto a substrate.

154. The method of claim 153 further comprising a step rotating the substrate.

155. The method of claim 146 further comprising a step of supplying the fluorine-containing compound as a glass precursor.

156. The method of claim 155 wherein the glass precursor comprises a chlorine, fluorine, and silica containing compound.

157. The method of claim 156 wherein the chlorine, fluorine, and silica containing compound comprises a chlorofluorosilane.

158. The method of claim 157 wherein the chlorofluorosilane is selected from a group consisting of $SiCl_3F$, $SiCl_2F_2$, and $SiClF_3$.

Substantially Water-Free Atmosphere

159. A method of manufacturing a optical fiber preform, comprising a step of depositing soot onto a substrate within a substantially water-free atmosphere.

160. The method of claim 159 further comprising a step of rotating the substrate.

161. The method of claim 159 wherein the substantially water-free atmosphere comprises dried air containing less than 100 ppm water vapor.

162. The method of claim 159 wherein the substantially water-free atmosphere further comprises less than 10 ppm water vapor.

163. The method of claim 159 wherein the substantially water-free atmosphere further comprises less than 3 ppm water vapor.

164. The method of claim 159 wherein the substantially water-free atmosphere further comprises less than 1 ppm water vapor.

165. The method of claim 159 wherein the atmosphere is selected from a group consisting of dry nitrogen, dry argon, dry helium, and combinations thereof.

166. The method of claim 159 wherein the atmosphere is selected from a group consisting of dry oxygen, dry carbon dioxide, and combinations thereof.

167. The method of claim 159 wherein the substantially water-free atmosphere further comprises less than 1% relative humidity at a temperature range between about -67°C and about 125°C.

168. The method of claim 159 further comprising the steps of: including the substantially water-free atmosphere in a housing, and including the preform within the housing.

169. The method of claim 168 further comprising a step of mounting at least a portion of a combustion burner within the housing.

170. The method of claim 159 comprising the additional steps of: transferring the preform to another location for further processing, and including the preform within a substantially water-free atmosphere during the transfer.

171. The method of claim 159 further comprising a step of: inserting the preform into a carrier container included in the substantially water-free environment.

172. The method of claim 159 further comprising a step of transferring the preform to another process in a carrier container while subjecting the preform to a purge of substantially dry purge gas during the step of transferring.

173. The method of claim 172 wherein the dry gas purge is selected from a group consisting of dried air, dry nitrogen, dry oxygen, dry argon, dry helium, dry carbon dioxide, and combinations thereof.

174. The process according to claim 159 wherein the substantially dry atmosphere comprises a shroud of dry gas surrounding the soot and substantially preventing water from coming into contact with the soot during deposition.

175. A process for producing an optical fiber preform, the process comprising:

forming a silica-containing soot preform in a substantially water-free atmosphere;

transferring the soot preform to a consolidation process while the soot preform remains in a substantially water-free atmosphere; and

consolidating the soot preform in a consolidation furnace including a substantially water-free atmosphere.

Transfer In Substantially Water-Free Atmosphere

176. A method of manufacturing an optical fiber preform, comprising the steps of:

forming a soot preform at a first location, and

transferring the preform to a second location for further processing and during such transfer subjecting the soot preform to a substantially water-free atmosphere.

177. The method of claim 176 wherein the step of transferring the soot preform to a second location includes transfer to a holding or consolidation furnace.

178. The method of claim 176 further comprising a step of: inserting the soot preform into a carrier container.

179. The method of claim 178 further comprising a step of: subjecting the carrier container to a purge of substantially dry gas.

180. The method of claim 179 wherein the substantially dry gas is selected from a group of dried air, dry nitrogen, dry oxygen, dry argon, dry helium, dry carbon dioxide, and combinations thereof.

181. The method of claim 176 wherein the soot preform is formed by depositing silica containing soot onto a rotating mandrel.

182. The method of claim 176 wherein during the step of transferring, substantially continuously subjecting the soot preform to a purge of substantially dry gas.

183. A method of manufacturing an optical fiber soot preform, comprising the steps of:

forming a silica containing soot preform at a first processing step,

inserting the soot preform into a carrier container,

moving the soot preform housed within the container to a second processing step, and during such movement substantially continuously subjecting the soot preform to a substantially water-free atmosphere (34a).

184. A method of manufacturing an optical fiber soot preform, comprising the steps of:

moving the a silica-containing soot preform from one processing step to another processing step, and during such movement subjecting the soot preform to a purge of substantially water-free atmosphere.

Combination of Hydrogen-Containing and Substantially Hydrogen-Free Fuel

185. A method of producing silica-containing soot, comprising the steps of: supplying a combination of substantially-hydrogen-free fuel and combustion-enhancing additive to a burner.

186. The method of claim 185 wherein the combustion-enhancing additive comprises a compound that increases the combustion rate of the substantially-hydrogen-free fuel.

187. The method of claim 185 wherein the combustion-enhancing additive comprises a compound that increases the combustion heat emitted from the substantially-hydrogen-free fuel.

188. The method of claim 185 wherein the combustion-enhancing additive comprises a catalytic additive.

189. The method of claim 188 wherein the catalytic additive is selected from a group consisting of hydrogen (H_2), water (H_2O), peroxide (H_2O_2), methane (CH_4), ethane (C_2H_6), propane (C_3H_8), ethylene (C_2H_4), acetylene (C_2H_2).

190. The method of claim 188 wherein the catalytic additive is selected from a group consisting of D_2, D_2O, D_2O_2, CD_4, C_2D_6, C_3D_8, C_2D_2, C_2D_4.

191. The method of claim 188 wherein the catalytic additive is selected from a group consisting of ozone (O_3), HCN, and nitrous oxide (NO).

192. The method of claim 185 wherein the combustion-enhancing additive is an energetic fuel.

193. The method of claim 193 wherein the energetic fuel is selected from a group consisting of methane (CH_4), ethane (C_2H_6), propane (C_3H_8), ethylene (C_2H_4), acetylene (C_2H_2), C_2Cl_2, $(CN)_2$, and HCN.

194. The method of claim 185 wherein the combustion-enhancing additive is an energetic oxidizer.

195. The method of claim 185 wherein the combustion-enhancing additive is supplied in an amount of less than about 20% by volume of the substantially hydrogen-free fuel.

196. The method of claim 185 wherein the combustion-enhancing additive is supplied in an amount of less than about 5% by volume of the substantially hydrogen-free fuel.

197. The method of claim 185 wherein the combustion-enhancing additive is supplied in an amount of less than about 1% by volume of the substantially hydrogen-free fuel.

198. The method of claim 185 wherein the silica-containing soot is deposited onto a rotating substrate to form a preform.

199. The method of claim 185 further comprising igniting the combination to form a flame and flowing a glass precursor into the flame.

Induction Heater To Form A Glassy Barrier Layer

200. A method of manufacturing an optical fiber preform, comprising the steps of:

forming a first silica soot section of the preform, and

exposing at least part of the length of the section to heat generated by an induction heater to form a glassy barrier layer on only a surface of the section.

201. The method of claim 200 wherein the step of forming further comprises depositing silica-containing soot onto an outer surface of rotating deposition surface.

202. The method of claim 200 further comprising an additional step of depositing a second silica-containing soot section over top of the glassy barrier layer.

203. The method of claim 202 wherein at least one of the first and second silica-containing soot sections comprises a fluorine dopant

204. The method of claim 200 wherein the step of exposing comprises exposing at least the entire useable length (L) of the preform 20 to the heat.

205. The method of claim 200 wherein the step of exposing comprises providing to a coil of the heater a current in a range between about 2.0 and 4.0 kilowatts.

206. The method of claim 200 wherein the step of exposing comprises traversing the induction heater at an axial speed in a range between about 0.5 cm/s and 3.0 cm/s.

207. The method of claim 200 wherein the step of exposing comprises rotating the preform at a rotational rate of between about 80 rpm and 160 rpm.

208. The method of claim 200 wherein prior to the step of exposing the induction heater is stored in a position A off an end of the preform 20.

209. The method of claim 200 wherein the step of exposing comprises forming a barrier layer at least 10 μm in thickness.

210. The method of claim 200 wherein during the step of exposing, a burner used for forming the first silica-containing section is moved aside such that a soot stream emitted from the burner does not contact the preform.

211. The method of claim 200 wherein during the step of exposing, a flame of a burner used for forming the first silica-containing section is deflected aside by a deflector.

212. The method of claim 211 wherein the deflector is moveable.

213. The method of claim 200 wherein the step of exposing takes place within a deposition chamber.

214. The method of claim 200 wherein during the step of exposing, a space between a susceptor of the heater and the preform is purged with helium.

215. An apparatus for manufacturing an optical fiber preform, comprising:

a lathe adapted to support a silica soot section of the preform within a deposition chamber, and

an induction heater mounted proximate the lathe and adapted to generate heat to form a glassy barrier layer on the preform.

216. The apparatus of claim 215 wherein the induction heater further comprises an induction coil wound about a susceptor.

217. The apparatus of claim 216 wherein the susceptor comprises a graphite annulus.

218. The apparatus of claim 216 wherein the susceptor and the induction coil encircle the preform when forming the glassy barrier layer.

219. The apparatus of claim 215 wherein the induction heater comprises a drive apparatus to position the heater at a position off an end of the preform during deposition of soot on the silica soot section.

220. The apparatus of claim 215 wherein the induction heater comprises a drive apparatus adapted to traverse the induction heater along a length of the silica soot section.

221. The apparatus of claim 215 further comprising a deflector adapted to deflect a flame of a soot-producing burner from the preform during formation of the glassy barrier layer.

222. The apparatus of claim 215 further comprising a gas supply adapted to supply helium gas to a space between the preform and a susceptor of the induction heater.